



# An Overview of the Team Software Process<sup>SM</sup> and the Personal Software Process<sup>SM</sup>

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**Sponsored by the U.S. Department of Defense**

<sup>SM</sup> Personal Software Process, PSP, Team Software Process, and TSP are service marks of Carnegie Mellon University.



# Service Marks

**Personal Software Process<sup>SM</sup>,**

**PSP<sup>SM</sup>,**

**Team Software Process<sup>SM</sup>,**

**and TSP<sup>SM</sup>,**

**are service marks of Carnegie Mellon  
University.**



# Agenda

**The Software Business**

**Software Process Improvement Tools**

**Personal Software Process Overview**

**PSP Results**

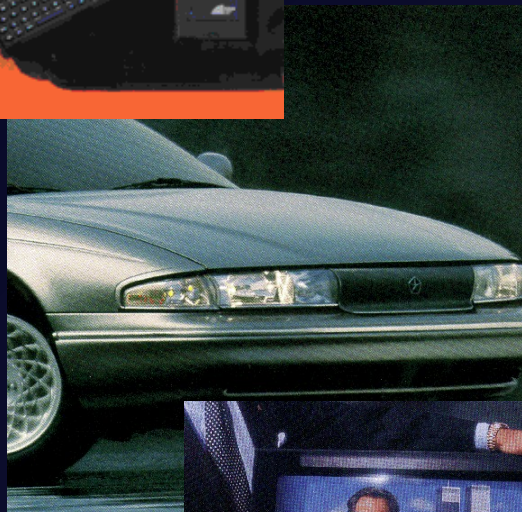
**Team Software Process Overview**

**TSP Results**

**Introduction Strategy**



# The Software Business -1



**All businesses are becoming software businesses.**

**Software costs and schedules now dominate many business plans.**

**Software quality limits our ability to field many critical systems.**

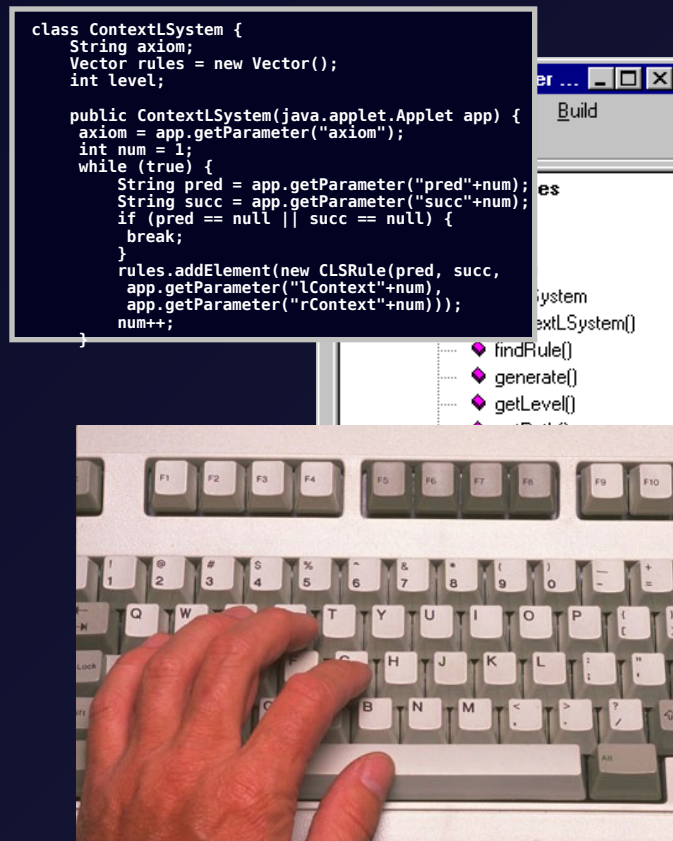


# The Software Business -2

**Software products are made of instructions, each individually handcrafted by a software engineer.**

**Most software products are built by small teams of software engineers.**

**Team performance plus individual skills and discipline govern results.**





# The Software Business Challenge

## **Increasing pressures to improve performance**

- **tight resources**
- **demanding customers**
- **growing competition**

## **Poor performance of software organizations**

- **cost and schedule commitments**
- **product quality**

## **Difficulties with software process improvement**

- **long time**
- **limited process skills**



# Meeting the Challenge

**PSP and TSP directly address the software business challenge.**

- **They show managers and engineers how and why to plan and track their projects.**
- **They demonstrate the principles and benefits of effective quality management.**
- **They involve the engineers in process measurement, management, and improvement.**
- **They accelerate the transition to mature, high-performance software engineering teams.**



# SPI Tools: CMM + PSP + TSP

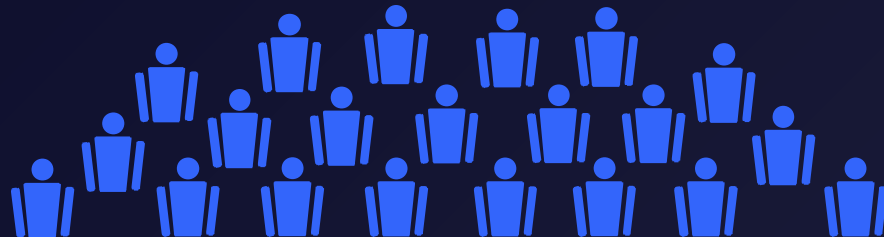
**CMM** - Improves  
*organization's  
capability,  
management focus.*



**TSP** - Improves team  
*performance, team  
and product focus.*



**PSP** - Improves  
*individual skills and  
discipline, personal  
focus.*





# CMM KPAs in PSP and TSP

Level	Focus	Key Process Areas (KPA)
<b>5 Optimizing</b>	Continuous process improvement	<ul style="list-style-type: none"> <li>✓Defect prevention</li> <li>✓Technology change management</li> </ul>
<b>4 Managed</b>	Product and process quality	<ul style="list-style-type: none"> <li>✓Process change management</li> <li>✓Quantitative process management</li> <li>✓Software quality management</li> </ul>
<b>3 Defined</b>	Engineering process	<ul style="list-style-type: none"> <li>✓Organization process focus</li> <li>✓Organization process definition</li> <li>Training program</li> <li>✓Integrated software management</li> <li>✓Software product engineering</li> <li>✓Intergroup coordination</li> </ul>
<b>2 Repeatable</b>	Project management	<ul style="list-style-type: none"> <li>✓Peer reviews</li> <li>✓Requirements management</li> <li>✓Software project planning</li> <li>✓Software project tracking</li> <li>✓Software quality assurance</li> <li>✓Software configuration management</li> </ul>
		Software subcontract management

✓CMM Key Process Area fully or partially addressed in PSP or TSP



# The Personal Software Process -1

**The PSP is a process designed for individual use, based on scaled down industrial software practice.**

**The principal objective of the PSP is to help software engineers to do better work.**

**The PSP is also designed to demonstrate the value of using defined and measured processes.**

**Finally, the PSP is intended to help engineers and organizations meet the increasingly stringent demands for quality software systems.**



# The Personal Software Process -2

**The PSP applies to structured personal tasks.**

- **developing program modules**
- **defining requirements or processes**
- **conducting reviews or tests**
- **writing documentation, etc.**

**PSP can be extended to support development of large-scale software systems.**

**It is a Level 5 process for individuals and a prerequisite for Team Software Process.**



# Personal Process Management

**The PSP moves process management and control to the engineer.**

**Engineers use their data to manage and improve their personal performance.**

**This provides**

- **better estimating, planning, and tracking**
- **protection against overcommitment**
- **a personal commitment to quality**
- **the engineers' involvement in continuous process improvement**



# Software Engineering with PSP

**PSP introduces engineers to a disciplined approach to software engineering.**

Process Framework

Project Management

Personal Reviews

Statistical Estimating

Measurement  
Framework

Quality Management

Software Design

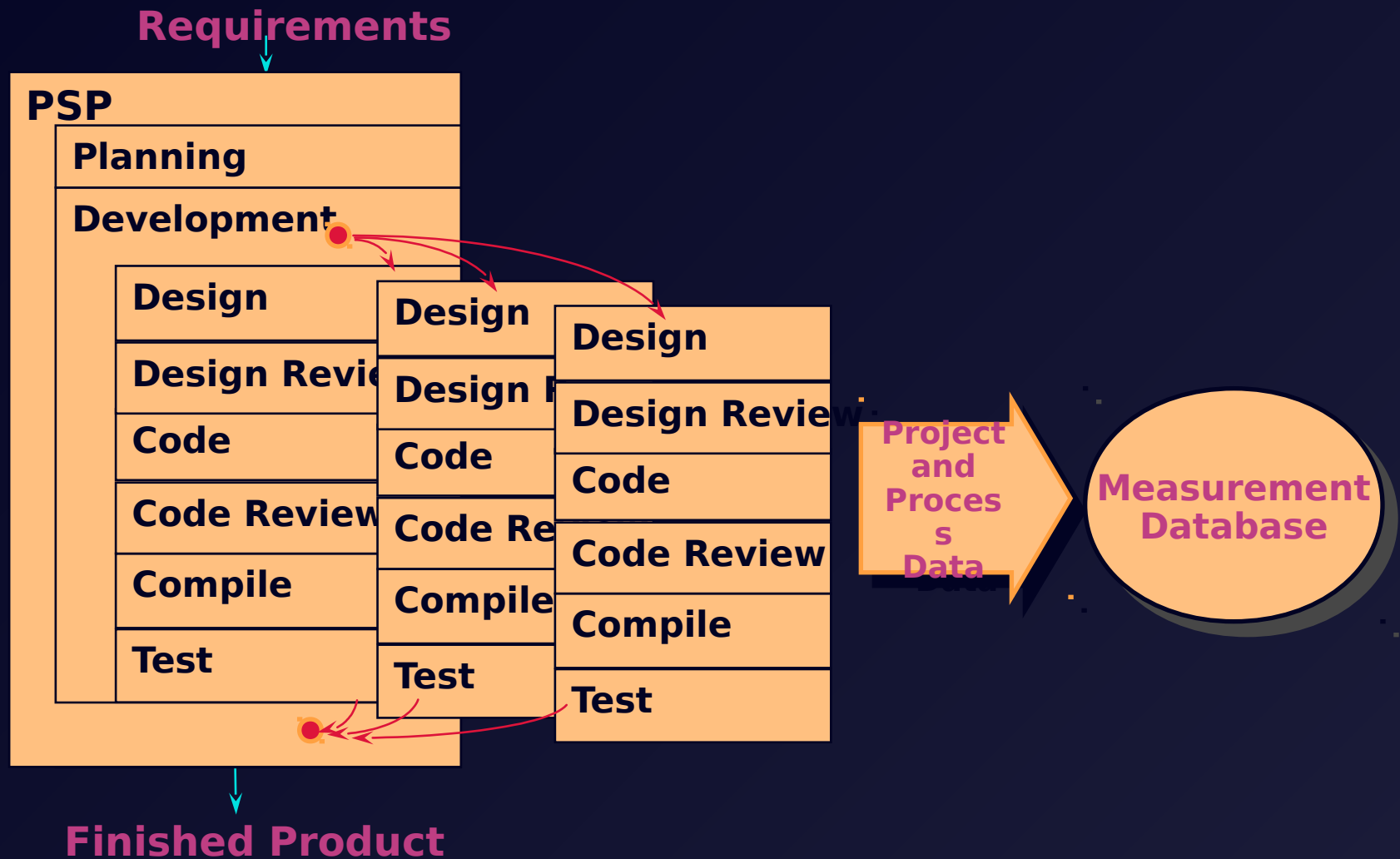
Statistical Analysis

**PSP motivates the use of these practices through:**

- **staged introduction strategy**
- **practice to build skills**
- **quantitative analysis of performance**



# The PSP Process Framework





# The PSP Measurement Framework

**With PSP, engineers use three basic measures:**

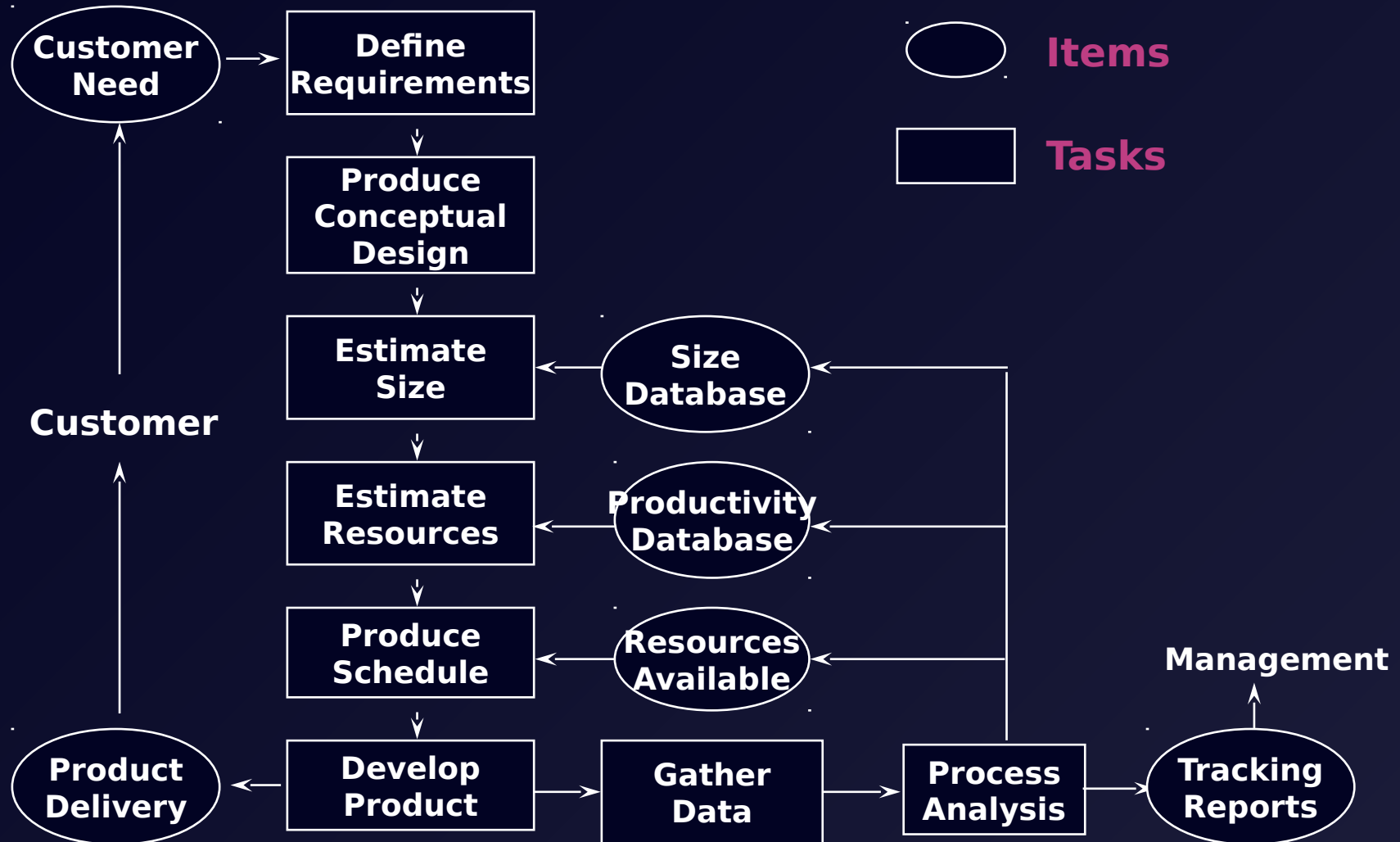
- **time in minutes by phase**
- **defects injected and removed by phase**
- **program size and a size proxy**

**Several derived measures are used to manage and improve the personal process.**

- **estimation accuracy**
- **prediction intervals**
- **productivity**
- **defect density**
- **review rate**
- **defect removal rate**
- **yield**
- **COQ A/F ratio**



# The PSP Planning Framework

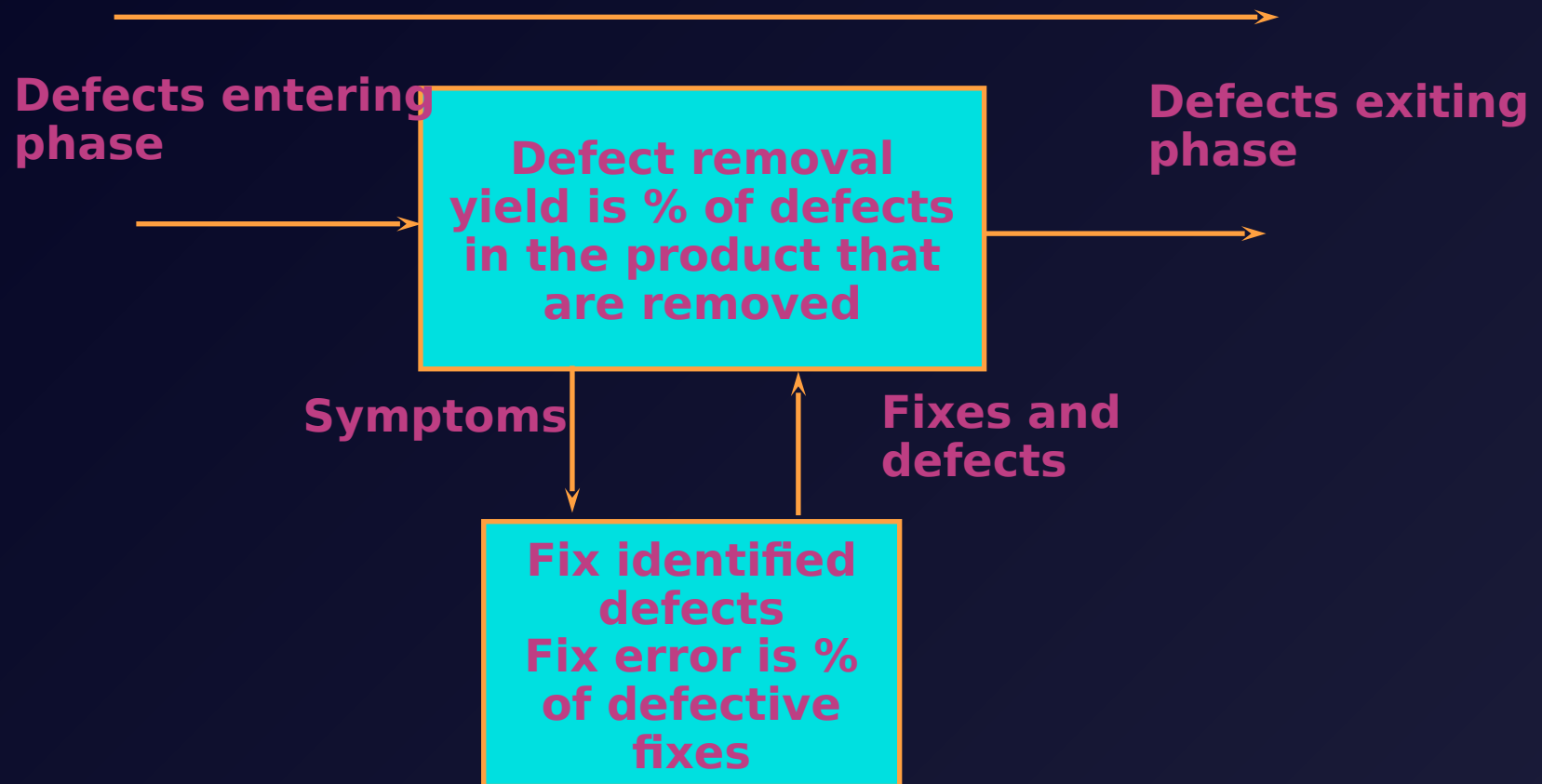






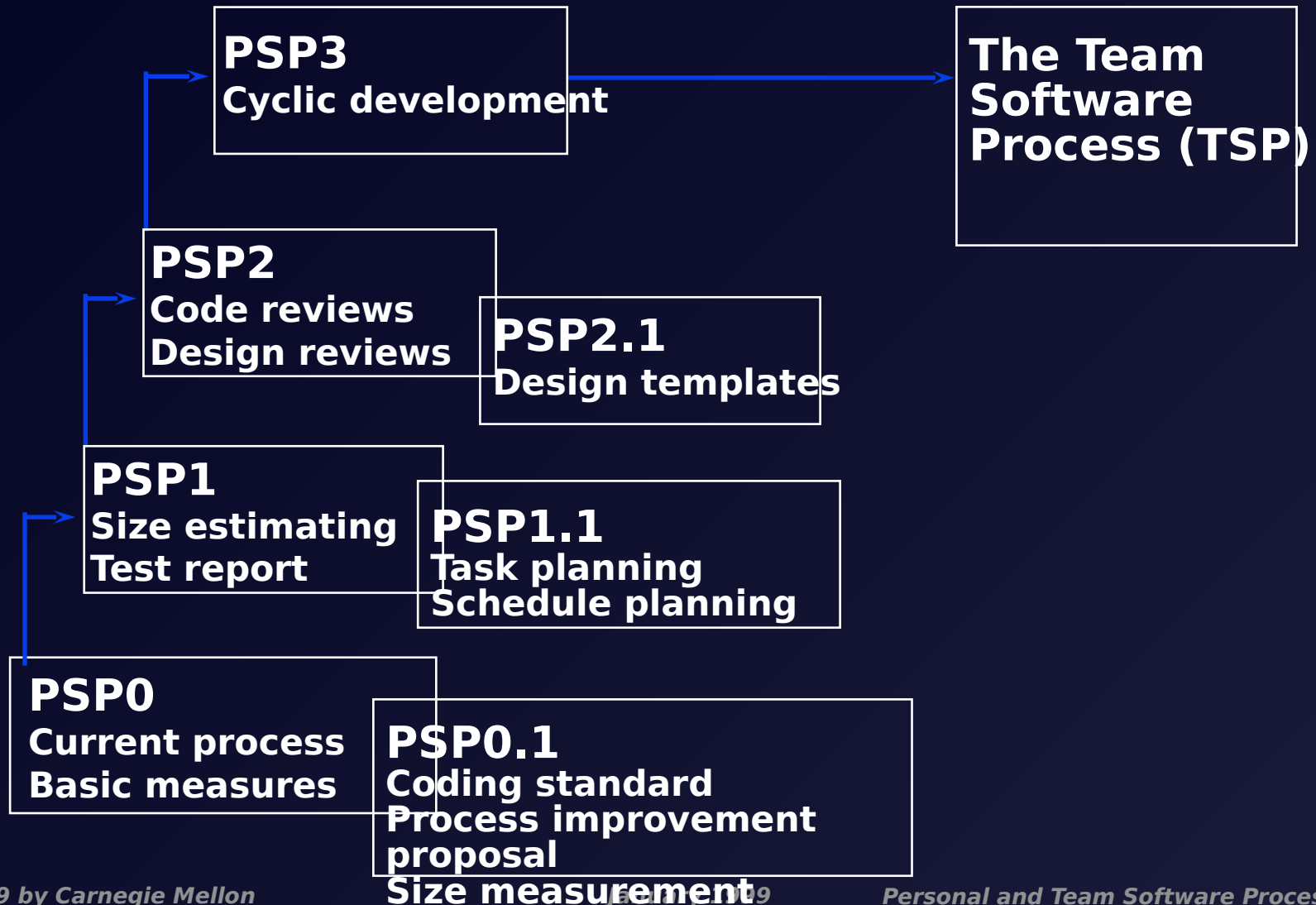
# The PSP Quality Framework

**A phase process yield =  $100 * (\text{defects found}) / (\text{found} + \text{not found})$**





# Learning The PSP





# PSP Results

**The following results are from a study of the impact of PSP on individual engineers during training.**

**23 classes provided data to the SEI**

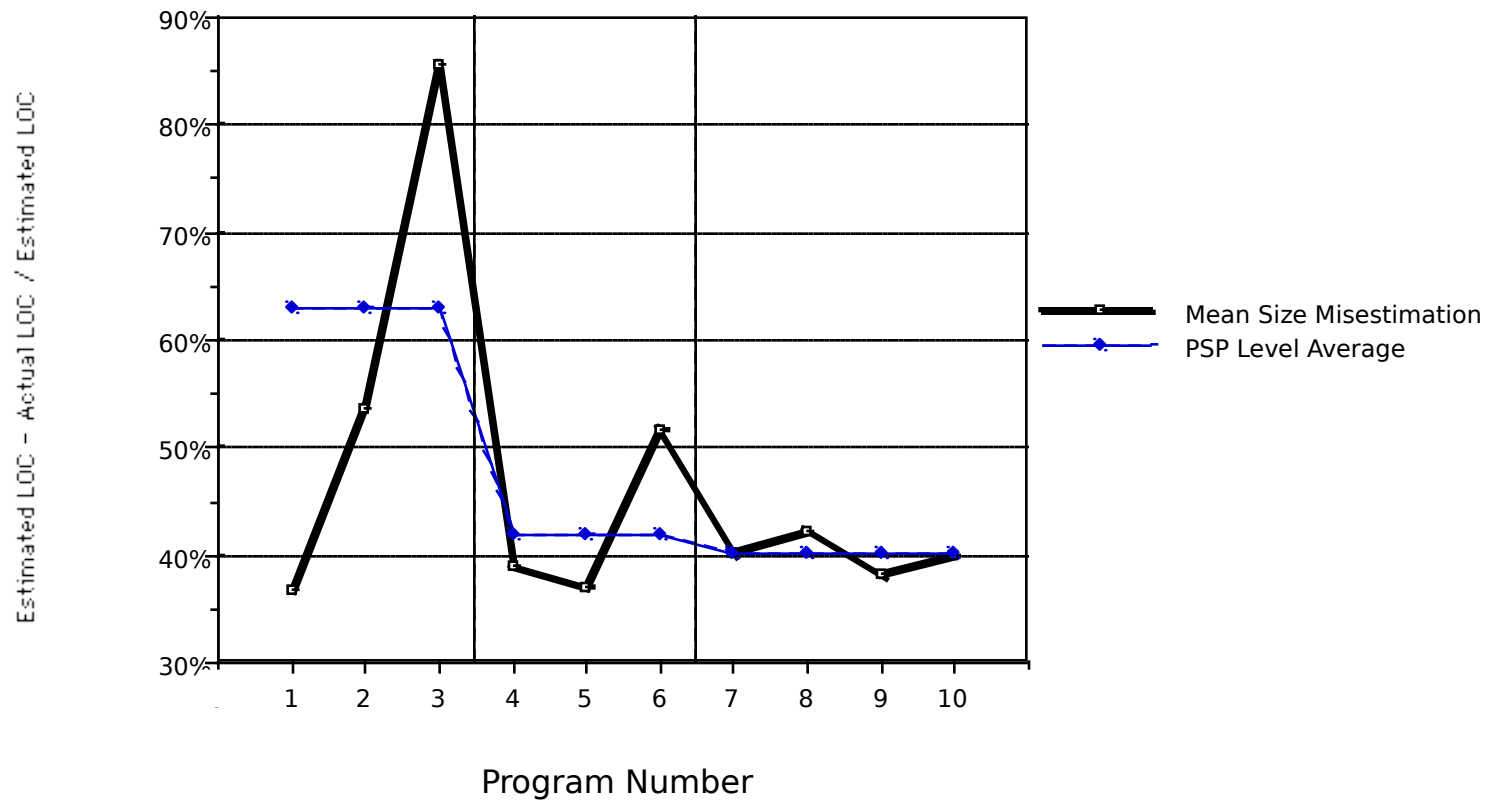
- **Instructor training led by SEI personnel**
- **Academic courses taken by graduate and undergraduate students**
- **Industry offerings where SEI and Non-SEI instructors taught on-site**

**Class size ranged from 4 to 24 students for a total of 298 students**



# Size Estimation Accuracy -1

Size Estimation Accuracy Trend



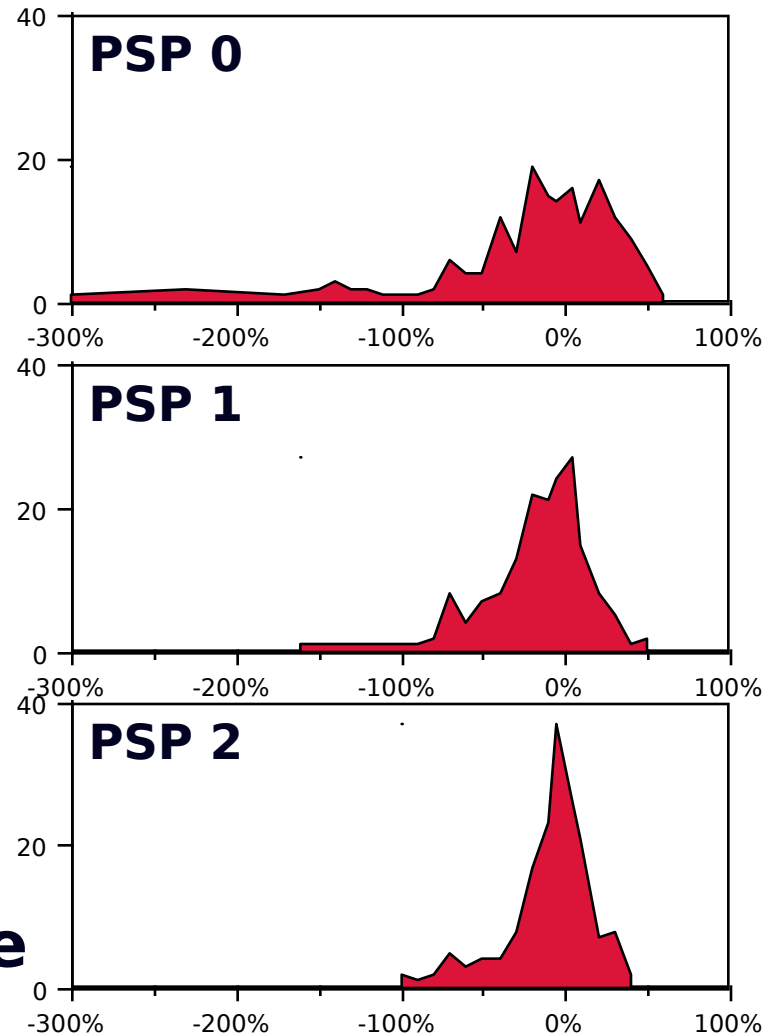


# Size Estimation Accuracy -2

**Many extreme underestimates**

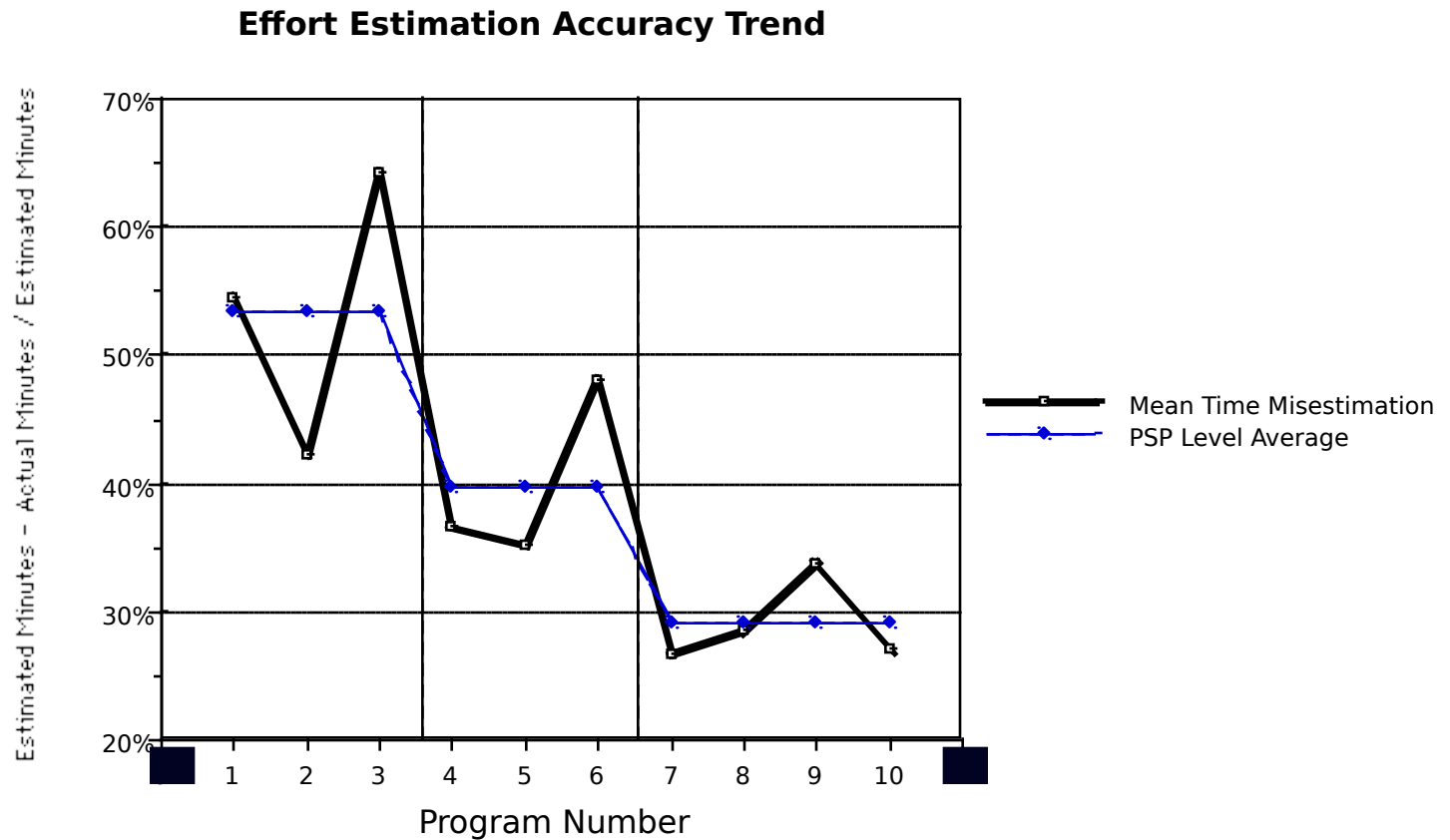
**Underestimates are less extreme**

**Much more accurate estimation of size**





# Effort Estimation Accuracy -1



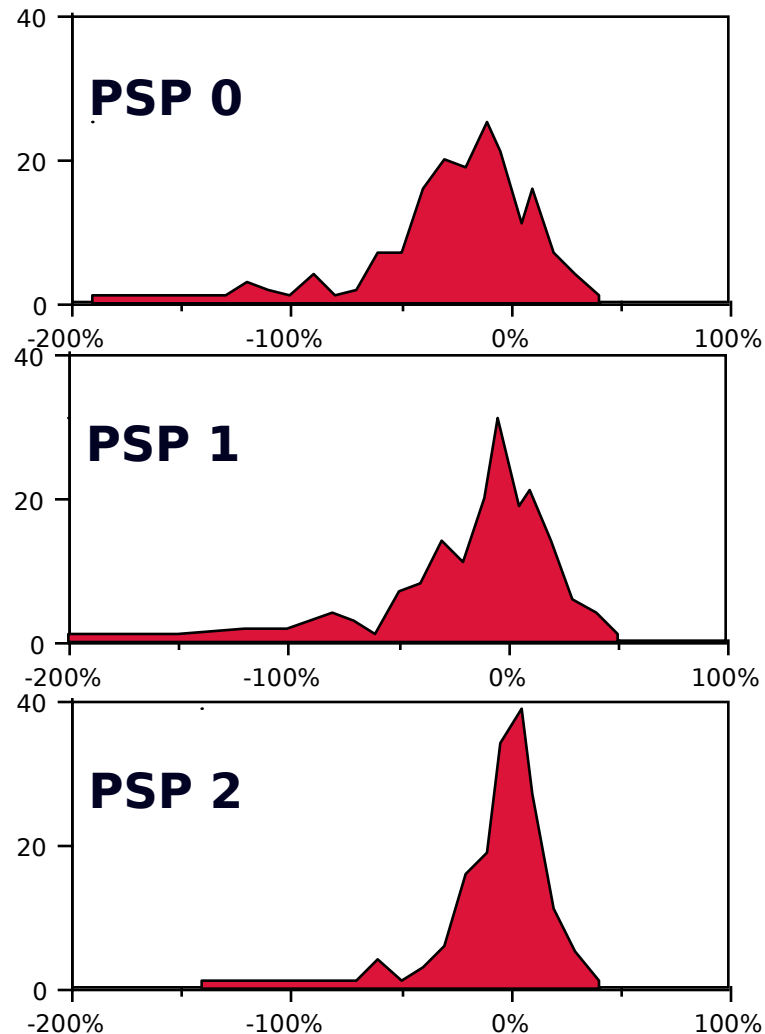


# Effort Estimation Accuracy -2

**Majority are  
under-estimating**

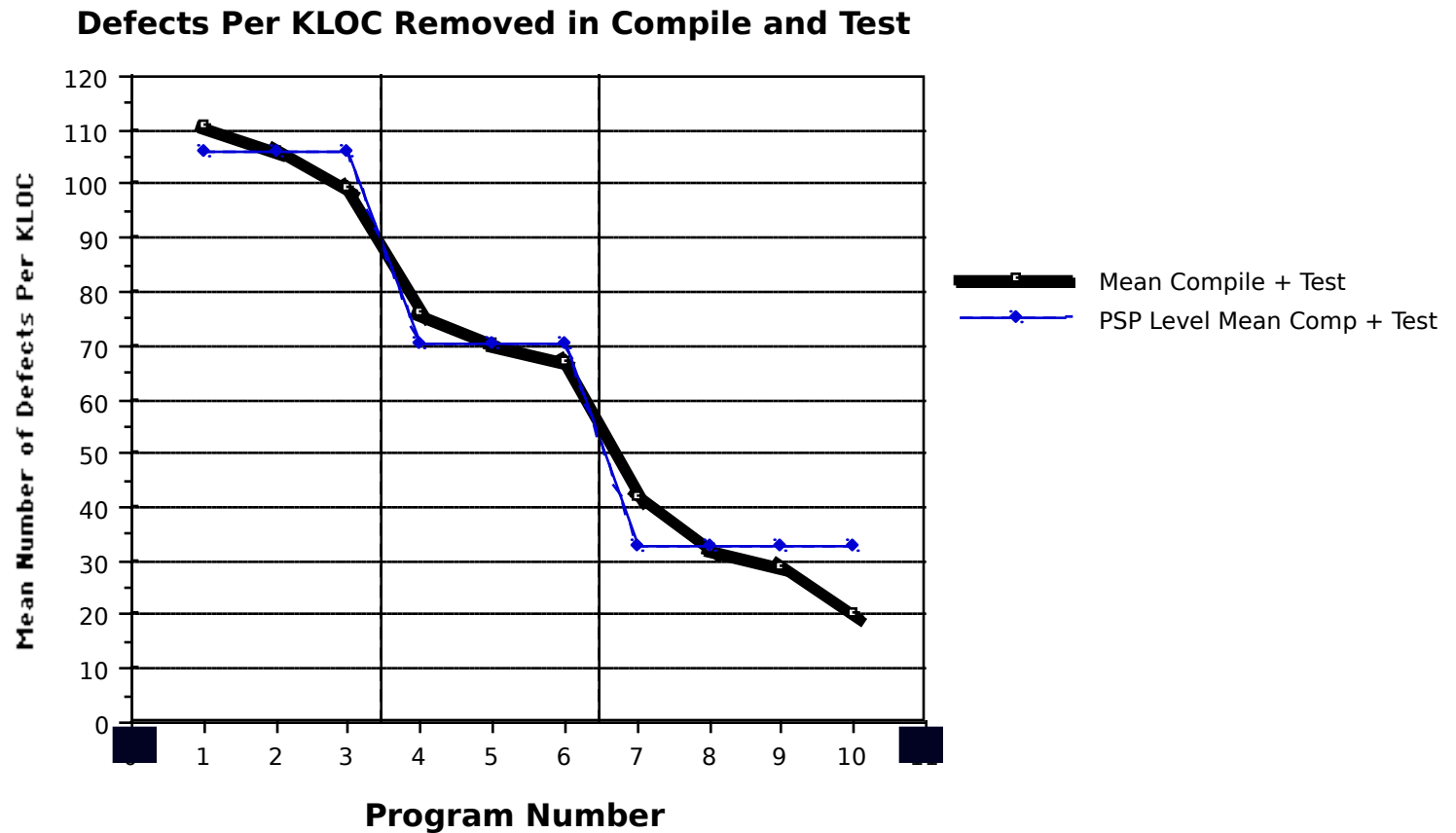
**Balance of over-  
and  
underestimates**

**Much tighter  
balance around  
zero**





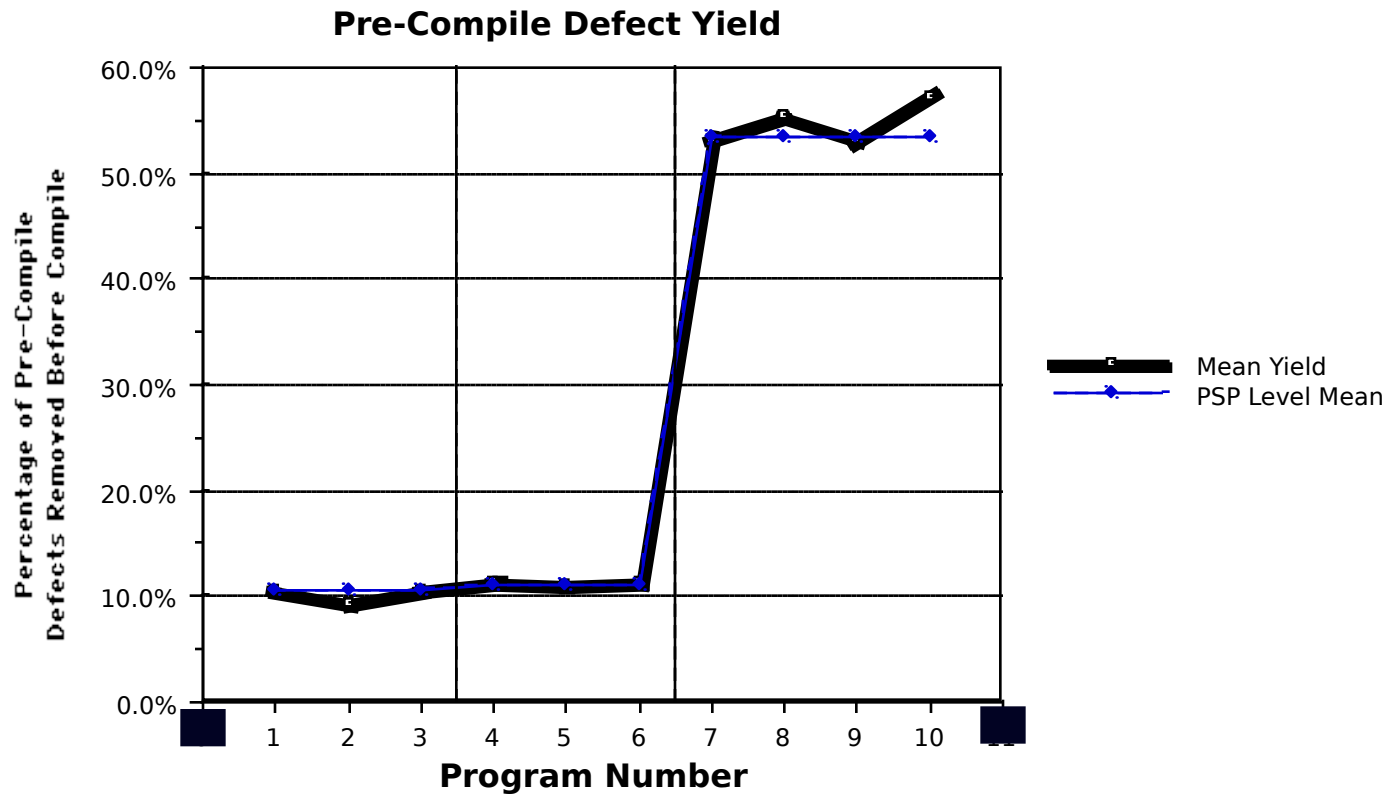
# Product Quality





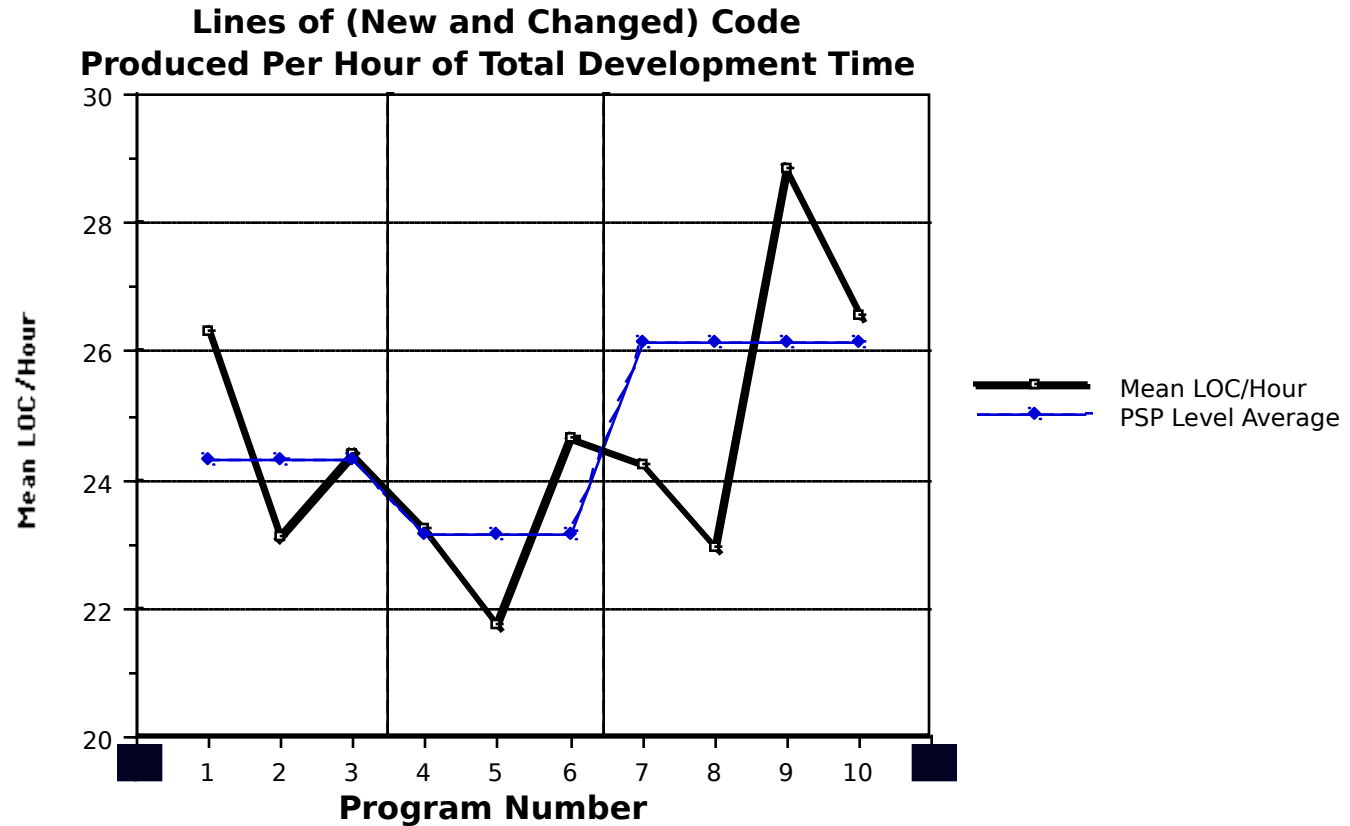


# Process Quality





# Productivity





# The Team Software Process

**Team Software Process (TSP) is a process for PSP-trained software engineering teams with 2 to 20 members.**

**TSP supports**

- **development, enhancement, and repair**
- **self-directed teams**
- **interdisciplinary teams**
- **isolated software teams**
- **statistical process control**

**Think of it as Level 5 process for teams.**



# What Is a Team?

**A team is a group of people who**

- **are working together**
- **have a common end objective**
- **do interdependent work**
- **depend on and support each other**
- **act, feel, and think like a close-knit group**

**Not all working groups are teams.**



# TSP Objectives

**TSP was developed to**

- **help software engineering teams build quality products within cost and schedule constraints**
- **accelerate software process improvement**
- **make Level 5 behavior normal and expected**

**A principal TSP design goal was to create a process that builds effective teams and optimizes team performance throughout the project.**



# Building Effective Teams -1

**Effective teams concentrate on the job.**

- **They know what are they trying to do.**
- **They have agreed-to roles.**
- **They have a common plan of action.**
- **And they know who will handle each task.**

**While there may be external pressure or interpersonal conflicts, effective teams are focused on the job, not the team dynamics.**



# Building Effective Teams -2

**The TSP builds effective teams through**

- **a defined teambuilding process**
- **a teamworking framework**
- **a supportive management environment**

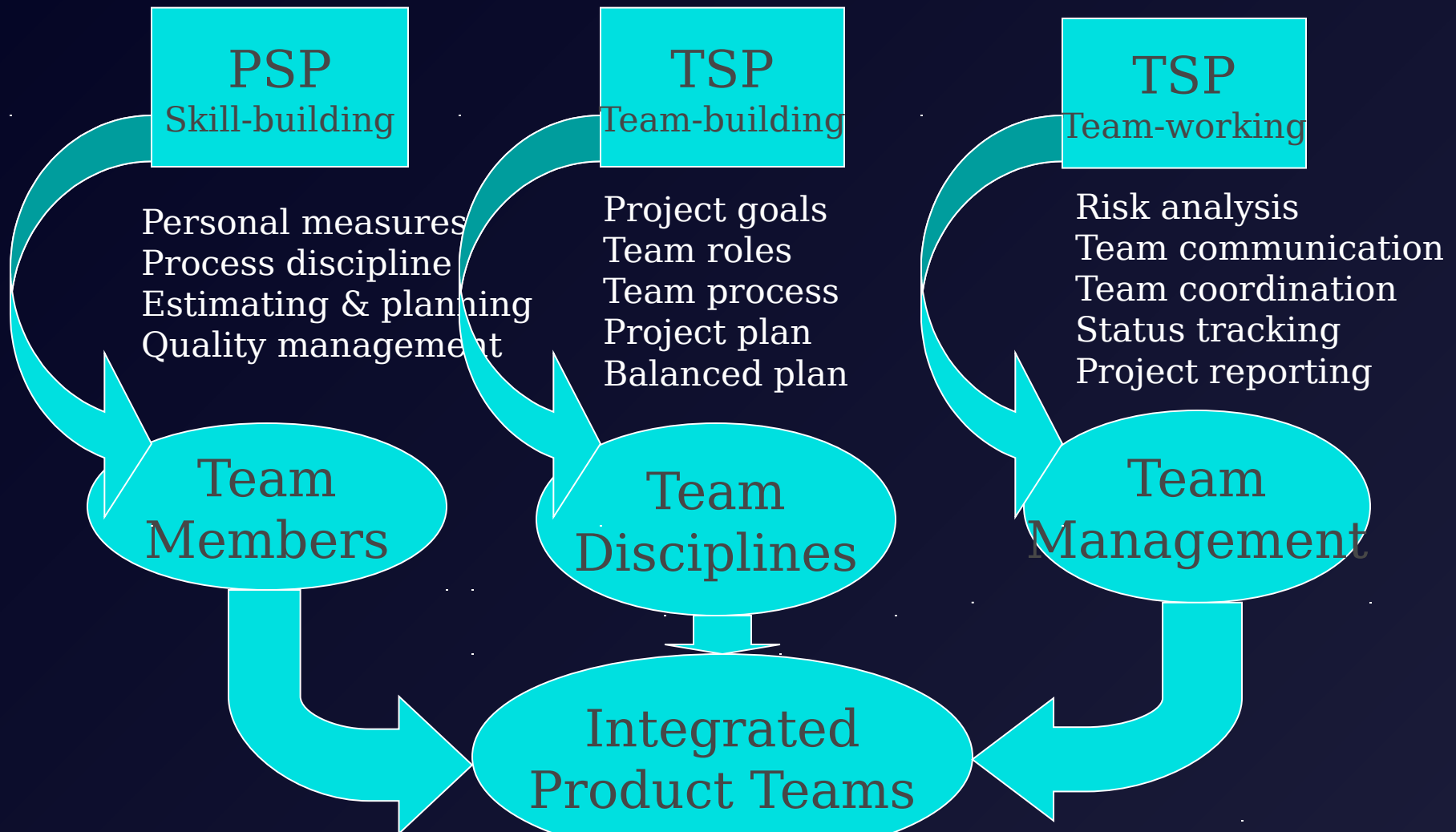
**To use the TSP, engineers must know how to**

- **define and use personal processes**
- **plan their work**
- **track their time and defects**
- **use earned value to track progress**
- **use process data to manage quality**

**Engineers learn these methods in PSP training.**



# Building Effective Teams -3







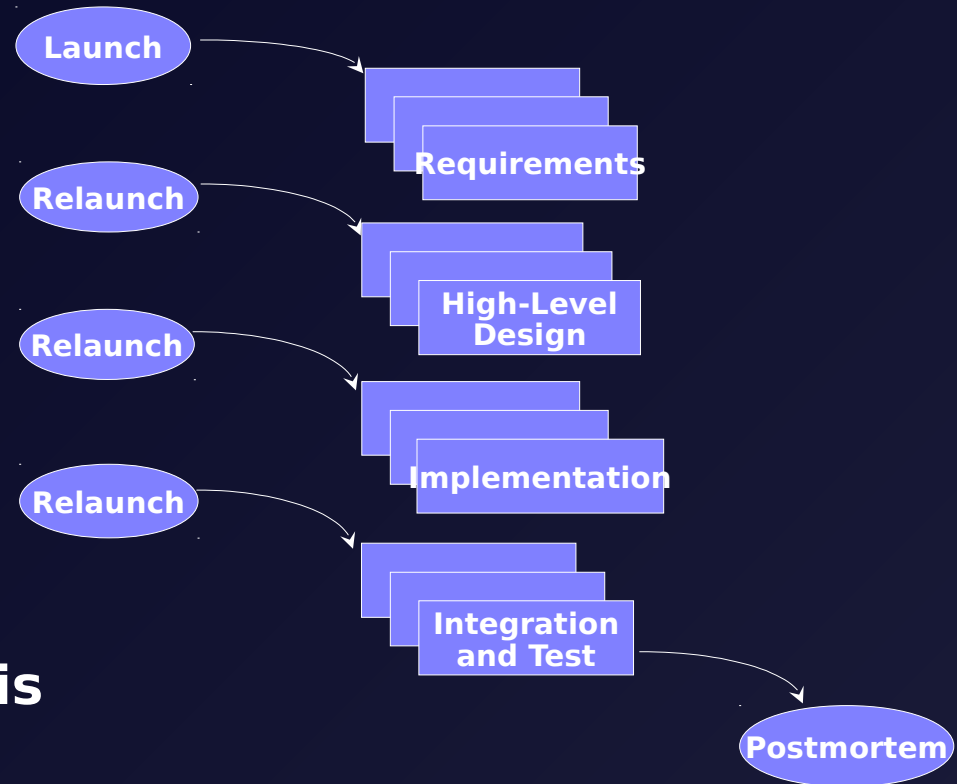
# TSP Structure and Flow -1

**TSP has four principal phases**

- Requirements
- Design
- Implementation
- Test

**Each phase starts with a launch or relaunch step.**

**A plan or revised plan is produced during each launch or relaunch.**



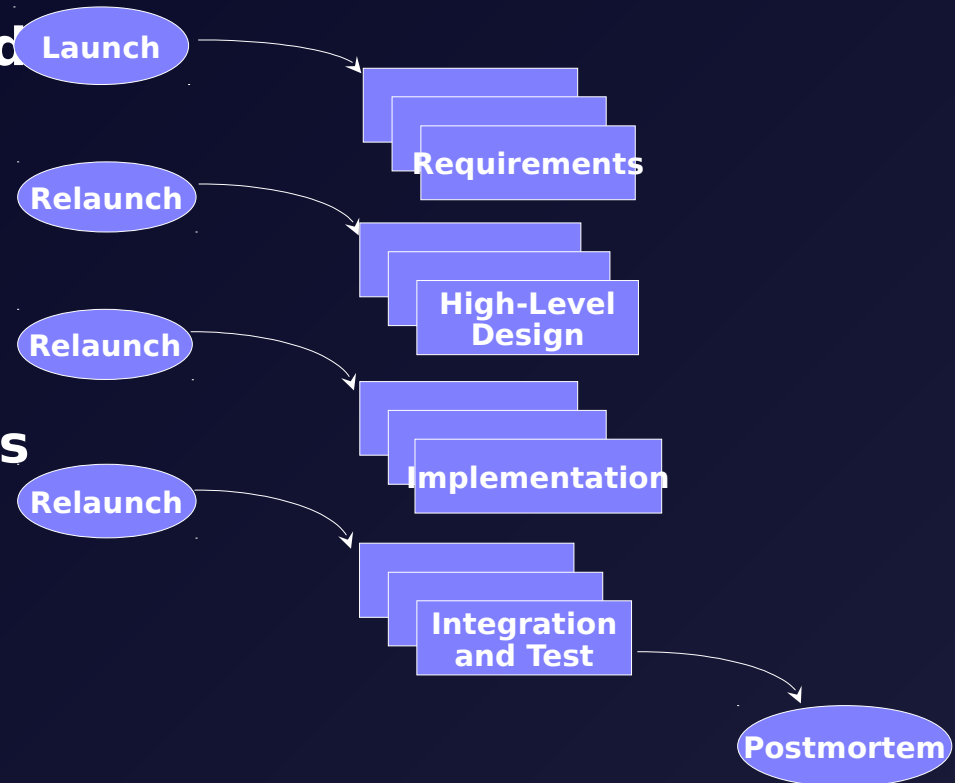


# TSP Structure and Flow -2

**The TSP phases can and should overlap.**

**The TSP development strategy is to**

- balance team workload
- develop in increments
- set and manage freeze points
- track task dependencies
- accelerate tasks that satisfy entry criteria
- minimize defect fix times



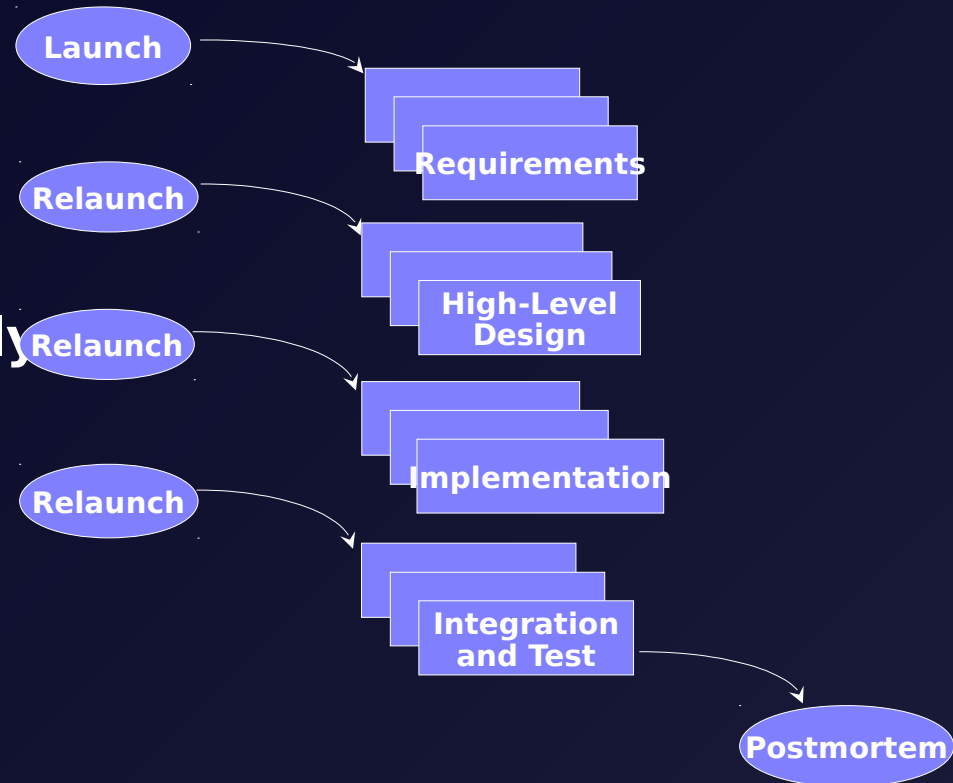


# TSP Structure and Flow -3

**TSP projects can start or end on any phase.**

- from requirements through system test
- requirements only
- high-level design only
- or any combination

**TSP permits whatever process structure makes the most business and technical sense.**





# TSP Process Inventory

## Development Scripts

### Overall Development Process

- Requirements
- High-Level Design
- Implementation
  - Unit Test and Test Development
- Integration and Test
  - Product Build
  - Integration
  - System Test

Project Postmortem

## General Purpose Scripts

### Team Launch/Team Relaunch

- Launch Meeting 1, 2, 3, 4, 5, and 6

Inspection Process

Test Defect Handling

General Meeting Process

Weekly Team Meeting

Management Status Meeting

Customer Status Meeting

## TSP Forms

Component Summary - Defects

Component Summary - Resources

Defect Reporting Form

Defect Recording Log

Inspection Report

Process Inventory

Issue/Risk Tracking Log

Launch Summary Form

Meeting Report Form

Process Improvement Proposal

Quality Plan

Task/Schedule Planning Templates

Team Roles

Time Recording Log

Weekly Status Report



# Team Member Roles -1

**Being a team-directed project means the team has to manage itself.**

- **plan and track work**
- **manage the quality of the work**
- **responsibly manage the project risks**
- **work aggressively to meet team goals**

**The team must also show management and the customer that they are managing themselves.**

- **frequently report status and progress**
- **anticipate, plan for, and report on project risks**



# Team Member Roles -2

**The self-management responsibilities are shared among the team members.**

**The eight team member roles are:**

- **Customer Interface Manager**
- **Design Manager**
- **Implementation Manager**
- **Planning Manager**
- **Process Manager**
- **Quality Manager**
- **Support Manager**
- **Test Manager**



# Team Member Roles -3

## **All team roles should**

- **get team input on their decisions**
- **perform their roles promptly and professionally**
- **train another team member as an alternate**

## **All team members should**

- **follow disciplined personal practices**
- **plan, track, and manage their personal work**
- **support and contribute to the team**



# The Team Leader's Role

**The team leader does not take one of these team roles.**

**The team leader's job is to**

- **coach the team**
- **provide support**
- **guide the team in doing their work**
- **establish and maintain high standards for the work**





# TSP Base Measures

**TSP uses the same base measures as the PSP**

- **product size in pages or lines of code**
- **time in minutes per phase or task**
- **defects injected and removed by phase**
- **schedule planning/tracking with earned value**

**All the other TSP measures are derived from these basic measures.**



# TSP Derived Measures and Charts

## **Partial list of derived measures**

- **Defect density by phase**
- **Percent defect-free by phase**
- **Phase yield, appraisal yield, process yield**
- **Inspection rates, review rates**
- **Development time ratios**
- **Defect ratios**

## **Partial list of analysis charts**

- **Component Defect Removal profile**
- **Component Quality profile**
- **Quality Profile Index**



# TSP Support Tool

**A tool is provided to support the process.**

**Planning and tracking at the team and individual level are the principal activities addressed by the TSP support tool.**

**An key feature is support for the collection, roll-up, and analysis of individual and team data**

- **size**
- **time**
- **defects**
- **earned value**



# The TSP Launch

**A 3-day TSP launch or a 2-day TSP re-launch workshop is used to start each project phase.**

**The launch workshops are part of the project.**

**They are planned and tracked.**

**The supervisor and all team members participate.**



# Purpose of the TSP Launch

**The purpose of the launch process is to establish a common team understanding of the project.**

- **the development work to be done**
- **management's goals for the project**
- **the team and team members' goals**
- **the processes the team will use**
- **the roles the team members will perform**
- **the plan for doing the work**
- **the management and customer reporting system**
- **the ongoing team communication process**



# Launch Process Meetings

**The launch process consists of six meetings.**

1. Set project goals and objectives and define team member roles
2. Produce development strategy and plans
  - quality plan
  - process plan and support plan
  - top-down plan, next-phase plan
3. Produce bottom-up plan for the next phase
  - individual plans
  - consolidated team plan
4. Conduct risk assessment
5. Conduct first weekly meeting
6. Review plans with management



# Launch Products

**The team produces a comprehensive plan during the launch workshop.**

- **team goals and objectives**
- **team role assignments**
- **development strategy**
- **incremental build plan**
- **requirements freeze points**
- **process plan**
- **quality plan**
- **overall plan**
- **next phase plan**
- **balanced work assignments**
- **individual team member plans**
- **consolidated team member plan**
- **risk assessment**



# The Weekly Team Meeting -1

**The weekly team meeting keeps the project on track by reviewing status and planned work for the team and each team member.**

**The meeting objective is to ensure that all team members**

- **understand current project status**
- **know what tasks are next**
- **are aware of everyone's status and progress**
- **know status against the quality plan**
- **discuss actions needed to ensure high quality**
- **understand the key project issues and risks**
- **participate in key team decisions**





# Weekly Team Meeting -2

**All team members attend.**

**The meeting is held at a regular time every week.**

**To prepare for the meeting, the team members**

- **plot their planned, actual, and projected earned value**
- **plot their actual versus planned project time**
- **summarize the tasks completed this week**
- **summarize status against quality goals**
- **summarize the status of assigned key risks**



# Weekly Team Meeting -3

**The team meeting follows a defined meeting process.**

- **prepare and distribute the meeting planning form in advance**
- **assign meeting roles**
- **prepare a meeting report**
- **distribute the report to all attendees**

**The team meeting concentrates on the data and key issues.**

**Most important, the meeting is action-oriented and brief.**



# The AIS Corporation -1

**Advanced Information Services (AIS) is an independent software contracting organization in Peoria, Illinois and Madras, India.**

**AIS has been working with SEI on process improvement and the PSP since 1992.**

**AIS has two SEI-authorized PSP instructors to train their engineering staff; they are also licensed by the SEI to deliver PSP training.**



# Reduced System Test Duration

**When pre- and post-PSP products of similar size are compared, AIS data reflect an order of magnitude reduction in system test duration — from months to days.**

	NO	Start Date	Size	Sys Test Duration	Sys Test Defects	Language
<b>Before PSP</b>	MODEL	8/91	30 req (est)	2 months	36	C
		3/94	19 req	3 cycles	7	C
	CMM	8/94	30 req	2 months	na	C
		1/95	15795 LOC	1.5 months	8	C++
<b>After PSP</b>		4/95	11681 LOC	1.5 months	1	C++
	CMM	8/95	24 req	5 days	8	C
	+ PSP	3/96	2255 LOC	2 days	0	C
		7/96	6196 LOC	4 days	0	PL *SQL
		7/96	1400 LOC	4 days	0	VB
		10/96	13263 LOC	2 days	4	PL *SQL
		1/97	4650 LOC	5 days	5	LOTUS MACR

[Source: AIS]



# Teradyne

**Teradyne is a supplier of automated test equipment.**

**They sent a manager to the SEI's PSP instructor authorization program.**

**This manager started PSP introduction with a PSP course for several teams.**

**They now have several teams that are using PSP and TSP in product development.**



# Teradyne Results

<b>Plan</b>	<b>Actual</b>	
<b>Size Estimate</b>	<b>110 KLOC</b>	<b>89,995 LOC</b>
<b>Effort Estimate</b>	<b>16,000 hours</b>	<b>14,711 hours</b>
<b>Schedule</b>	<b>77 weeks</b>	<b>71 weeks</b>

## **Product Quality (Defects/KLOC removed in phase)**

• <b>Integration</b>	<b>1 Def./KLOC</b>	<b>.2 Def./KLOC</b>
• <b>System Test</b>	<b>.1 Def./KLOC</b>	<b>.4 Def./KLOC</b>
• <b>Field Trial</b>	<b>0 Def./KLOC</b>	<b>.02 Def./KLOC</b>
• <b>Operation</b>	<b>0 Def./KLOC</b>	<b>n/a</b>

## **Measurable Benefits**

- **Quality levels improved 100 times over prior projects.**
- **Actual effort and schedule were within 8% of plan (early)**



# Hill Air Force Base

**The Hill Air Force Base software group develops avionics and support software for the US Air Force.**

**They sent several engineers to the SEI's PSP instructor authorization program.**

**They recently were assessed at CMM level 5.**

**They recently completed a pilot project using a PSP and TSP.**



# Hill Air Force Base Results

**The TaskView project was 25,820 lines of code.**

**The product was delivered a month ahead of the originally committed date, at almost exactly the planned cost.**

**Final test phases: system and operational tests**

- **only one high-priority defect found**
- **reduced from 22% to 2.7% of project schedule**

**The product is currently in acceptance testing with the customer; no defects have been found to date.**





# Getting Started with PSP/TSP

**Sprinkling a few PSP-trained engineers around the organization will not achieve useful results.**

**Installing PSP/TSP in the organization requires**

- **careful planning**
- **strong senior management involvement and sponsorship**
- **a change in behavior of both the software engineers and their managers**



# TSP Assumptions - 1

## **Organizational situation**

- **not at bottom of Level 1**
- **supportive management**
- **non-software team members**

## **Team preparation**

- **PSP-trained software engineers**
- **all participants trained in PSP principles**



# TSP Assumptions - 2

## **Project characteristics**

- **accessible customer**
- **range from large complex systems to small stand-alone programs**
- **include pure fix-based maintenance jobs**

## **Limited assistance for dysfunctional teams**

- **assumed to not be a general problem**
- **expect that assistance will be needed on role assignments and responsibilities**



# SEI Support for PSP/TSP

**SEI is helping organizations adopt PSP and TSP by providing on-site support for the initial introduction on pilot projects.**

**These collaborative efforts include:**

- **transition planning**
- **on-site PSP training**
- **PSP instructor authorization**
- **SEI-coached TSP launches on pilot projects**

**SEI-licensed PSP Transition Partners are also available to support PSP training and introduction.**



# SEI Introduction Strategy

**The SEI strategy for introducing PSP involves these steps:**

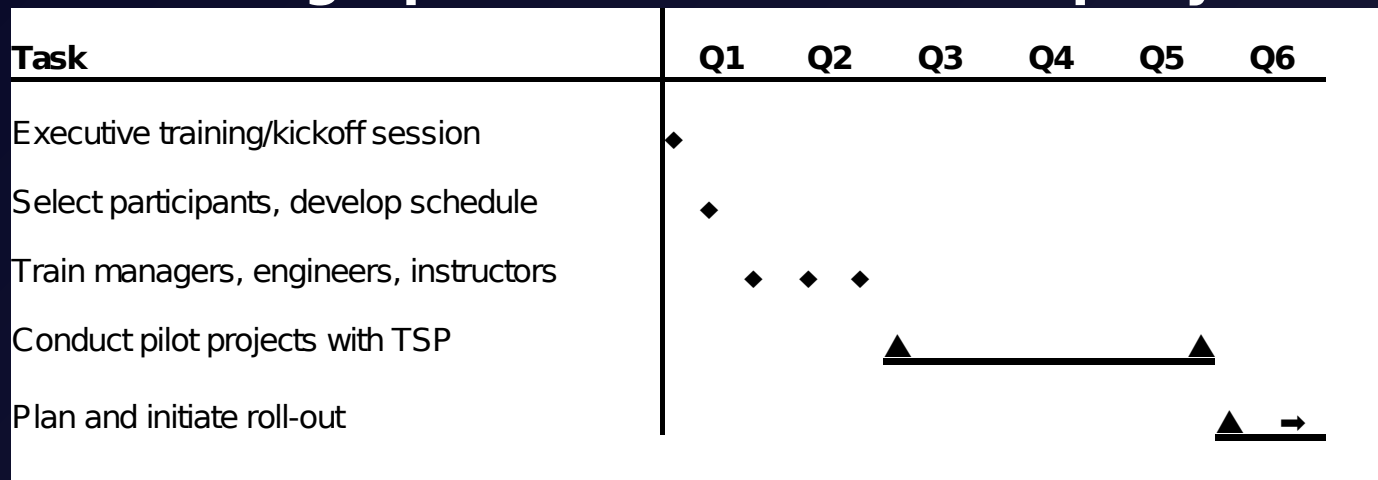
- **identify key areas for initial introduction**
- **hold executive kickoff and planning seminar**
- **identify and train affected managers and engineers**
- **train and authorize at least two PSP instructors**
- **establish needed support for pilot projects**
- **conduct 2 to 4 pilot projects using PSP/TSP**
- **plan and initiate rollout across the organization**



# Example Time-line for Introduction

## Example timeline

- based on 9-12 month pilot projects
- initial results are available within the first 6-12 months
- final results are available within 12-18 months
- demonstrates costs and benefits associated with PSP/TSP
- builds high-performance teams rapidly





# Messages to Remember

**The TSP is a mature process designed to help teams achieve their optimum performance.**

**PSP is a prerequisite for TSP.**

**TSP and PSP are tools for improving organizational processes at all maturity levels.**

**Early results suggest that teams using TSP/PSP are capable of ML5 performance levels**

- **predictable cost and schedule**
- **productivity increase/cycle time reduction**
- **world-class quality**



# Backup Material

## **SEI PSP course descriptions**

- **PSP Executive Seminar**
- **PSP for Software Managers**
- **PSP for Engineers Part I and II**
- **PSP Instructor Training**





# PSP Executive Seminar

**A one-day PSP seminar  
for software executives  
and middle managers**

**Describes the PSP from  
a software business  
perspective**

**Builds support for  
introducing PSP**

## Topics

### PSP Executive Seminar

- PSP and the software business
- The baseline process
- PSP planning methods
- PSP quality methods
- Managing with PSP
- PSP and the organization



# PSP for Software Project Managers

**One-week course for software project managers**

**PSP from a software project perspective**

**Builds the knowledge and skills for managing engineers that are PSP trained**

## Topics

### PSP for Software Project Managers

- PSP and the software business
- Introduction to the PSP
- Measurement in the PSP
- Estimating and planning methods in the PSP
- Defect management methods in the PSP
- Project cost, schedule, and quality management with the PSP
- Managing and coaching PSP-trained engineers



# PSP for Engineers Part I & II

**Two one-week courses  
for software engineers**

**Builds the discipline  
and skills to use and  
adopt PSP**

## Topics

### Part I: Planning

- Introduction to personal process
- Size measurement
- Size estimating
- Proxy-based estimating
- Resource estimating
- Process measurement

### Part II: Quality

- Defect management
- The design process
- Design verification
- Scaling up the PSP
- Process development
- Using the PSP



# PSP Instructor Training

**One-week course for training and authorizing PSP instructors.**

**Prepares instructor to**

- **teach the PSP**
- **transition PSP into the organization**

## Topics

### PSP Instructor Training

- Introduction to technology transition
- Securing management commitment
- Managing PSP-trained teams
- PSP course design
- Preparing to teach the PSP
- Using PSP data as a teaching tool
- Planning for PSP introduction